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### **Characterization of Palladium Modified Polythiophene Electrodes**

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Beamline(s): X18B

**Introduction:** Due to the high electrical conductivity, good chemical stability, and relatively easy synthesis, conducting polymers have been extensively investigated since their discovery in the seventies. An attractive field of application in electrochemistry is as support of electrocatalysts for several reactions such as those involved in energy conversion processes in fuel cells. In this work Pd particles were inserted into polythiophene (PT) films and studied for the activity for the hydrogen oxidation (HOR) and oxygen reduction (ORR) reactions in acid media.

**Methods and Materials:** Polymer host films were prepared using a strong acid aqueous solution by a method described in detail previously<sup>1</sup>. Pd particles were inserted in these films and studied for the electrocatalytic properties for the hydrogen oxidation reaction (HOR) and oxygen reduction reaction (ORR) in acid medium using the rotating disk electrode technique. In situ X-Ray Absorption Spectroscopy (XAS) was employed for the characterization of the Pd particles incorporated in the polymer.

**Results:** Pd particles were inserted into polythiophene (PT) films and studied for the activity for the hydrogen oxidation (HOR) and oxygen reduction (ORR) reactions in acid media. In situ XAS was employed for the characterization of the Pd particles and the results confirmed that they possess metallic character. At low potentials hydrogen is incorporated into the Pd lattice resulting in an increase in both the average Pd-Pd bond distance as well as the structural disorder. XAS results also indicated that a considerable fraction of the total Pd atoms is located in the surface of the electrodeposit, as expected for such a high surface area material. No activity for the HOR is seen for the PT films in absence of the catalysts. For the catalyzed PT films a chemical reaction involving atomic adsorbed hydrogen atoms on Pt or Pd and the carbon radical in the polaronic PT species may occur causing a progressive degradation of the film properties during HOR. The Pd modified electrode exhibits a considerable catalytic activity for ORR. Above 0.3 V only formation of hydrogen peroxide occurs, leading to a 2 electrons ORR mechanism. For smaller potentials, further reduction of H<sub>2</sub>O<sub>2</sub> to water occurs, resulting in a 4 electrons global process.

**References:** (1) M. T. Giacomini, E. A. Ticianelli, J. McBreen and M. Balasubramanian, *J. Electrochem. Soc.*, **148** (4), A323 (2001).